Final Technical Report
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CONSTRUCTION AND TESTING OF A MASS SIMULATOR FOR THE ONR-301 EHIC EXPERIMENT

The University of Chicago
Laboratory for Astrophysics and Space Research
Chicago, Illinois

Fred Sopron
EHIC Project Engineer

Introduction

The University of Chicago has built and qualified an Energetic Heavy Ion Composition Instrument (EHIC) which will be flown aboard either the TIROS 'I' or 'J' spacecraft. A Mass-Volume-Electrical Simulator (Mass Simulator) is required in the event that the instrument is not operational at launch or to provide ballast for whichever spacecraft the EHIC will not be installed upon at launch. This "smart dummy" was built and tested in 1990-91 and is awaiting delivery to GE for installation upon a designated spacecraft.

Requirements

The Mass Simulator must have the same mass, Center of Gravity (CG), approximate shape and thermal isolation properties as the EHIC instrument.

It must be fabricated of flight quality materials and components, meet the electrical interface requirements relating to proper termination of harness cables and satisfy contamination control requirements as specified for all TIROS spacecraft instrumentation.

Finally, it must meet the vibration constraints regarding first mode natural frequency (>100 Hz), successfully complete Qualification level vibration tests and be capable of surviving the Acoustic level vibration as specified.

Reference documents:

1) TIROS General Instrument Interface Specification (GIIS) IS-2280259 Rev. A 7/7/87
2) Unique Instrument Interface Specification (UIIS) IS-2629302,3,4
3) Performance Assurance Requirements for the STP Instruments (PAR) GSFC-IS-480-34 4/89

Timeline

Design and construction of the Simulator was scheduled to begin in June 1990 but did not proceed until September due to a scheduling conflict with the mechanical designer. Fabrication of the mechanical parts and construction of the printed circuit board began in late September. The p.c. board was thermal cycled on 25 Oct 1990 and conformal coating was completed on 29 Oct 1990. Final assembly began in late November with completion on 4 Dec 1990.

The limited facilities which were capable of performing the required vibration tests had scheduling conflicts which prevented any testing before late December 1990. A follow-up vibration study was conducted on 12 April 1991.

Construction

The Mass Simulator was constructed of type 6061 T6 aluminum stock. All surfaces were treated with Black Anodize, Hard Coat per MIL-A 8625D.

The EHIC instrument is a box-like structure with two cylindrical appendices (solid state detector telescopes) protruding from the front (-X) surface. Duplication of the CG in the simulator to within 1/8 in. was obtained by permanently attaching weighted blocks to selected locations on the inner surfaces. The telescopes were not simulated, resulting in a flat front surface which will be significantly less complicated to thermal tape than the EHIC instrument. Refer to pages 4 & 5 for comparison drawings.

In addition, exact duplication of the box-like structure allows the same multi-layer insulating blanket (MLIB) to be installed around either unit for flight. If both units are to be flown, with the Mass Simulator being used as ballast for the remaining spacecraft, its MLIB can be duplicated from the original EHIC thermal blanket drawing.

Three flight quality connectors are wired to a small printed circuit board which contains terminating resistors (10kΩ) that prevent cable crosstalk. (Refer to drawing on page 6)

The EHIC thermal control system (TCE) was not required to be installed in the simulator since the unit is thermally isolated from the spacecraft.

The weight of the Simulator is within 1/4% of the EHIC instrument.

Testing

The Mass Simulator was subjected to a series of electrical and mechanical tests in order to certify the unit as flight quality.

The final electrical interface assembly consisting of the printed circuit board and three connectors was exposed to high and low temperature extremes through four cycles in order to verify reliability of the solder connections and 'age' the resistors, then the P.C. board was conformal coated. The temperature shock profile is detailed on page 7.

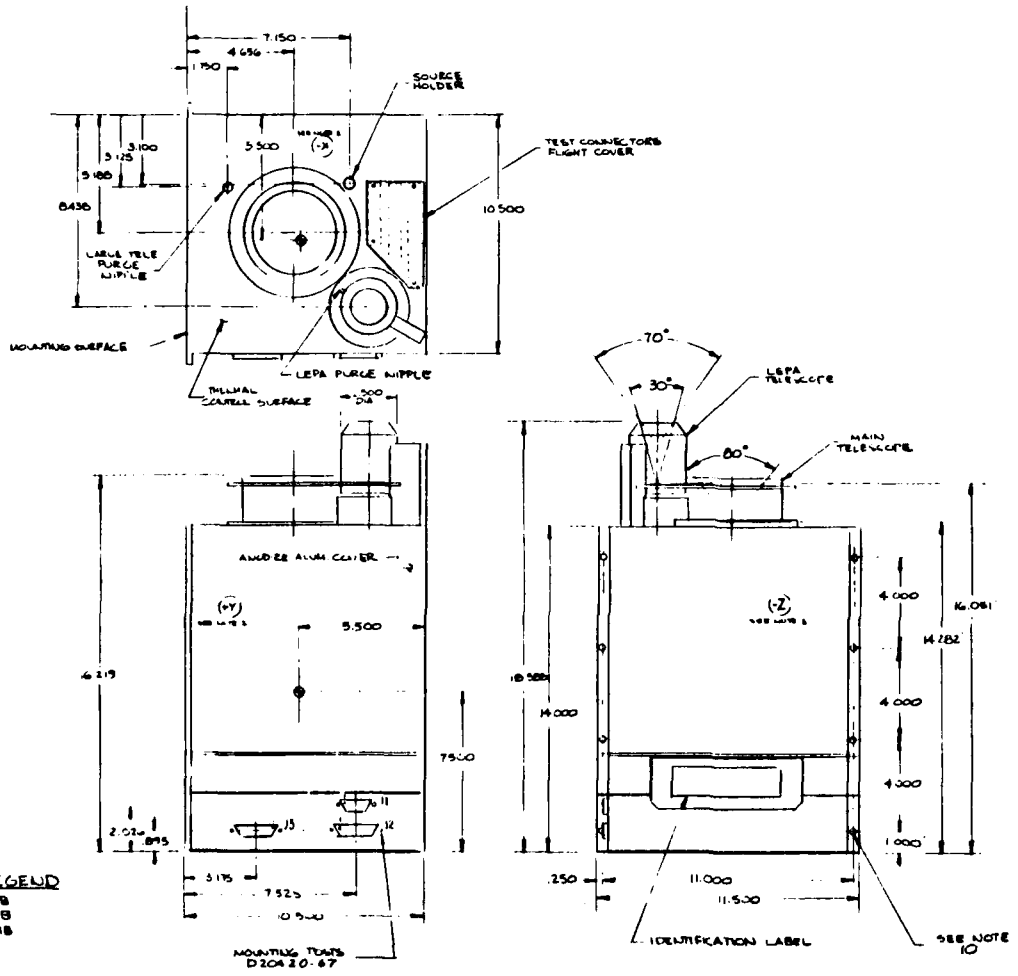
Initial vibration tests on the completed simulator took place on 19 & 20 December 1990 at Trace Laboratories in Chicago, Illinois. The unit was subjected to Random, Sine Burst and Shock Spectrum tests as specified in the environmental section of the Performance Assurance Requirements. Upon reviewing the data with the GSFC TIROS group it was determined that, due to anomalies in the results as seen on the Power Spectral Density (PSD) plots, a review of the test results would be performed by the spacecraft contractor to determine if the unit successfully met the vibration criteria.

Subsequent discussions with GE resulted in the decision that the unit should repeat the vibration series if a low level sine-survey verified the initial anomalies. A contract extension was requested since, with short notice, it was impossible to secure time at a vibration facility which would have the required equipment to accurately perform the follow-up study.

On 12 April 1991, a study was performed at Elite Electronics in Chicago, Illinois. A low level survey was performed at each axis on a vibration machine which utilized a slide-table for two of the three axes. The resulting plots indicated no abnormal first mode resonances at frequencies below 100 Hz. (Refer to page 8 for examples of the resulting surface response plots) These data confirmed the belief that the initial data was 'skewed' due to rotational forces introduced by a machine which lacked a slide-table. The new results were reviewed by GE and the unit was determined to be acceptable.

Conclusion

The completed and qualified EHIC Mass Simulator is currently being stored in the Laboratory for Astrophysics and Space Research at the University of Chicago until delivery instructions are received. It is anticipated that the unit will be shipped to GE in the first quarter of 1992 and installed on TIROS 'J' to support vibration tests.

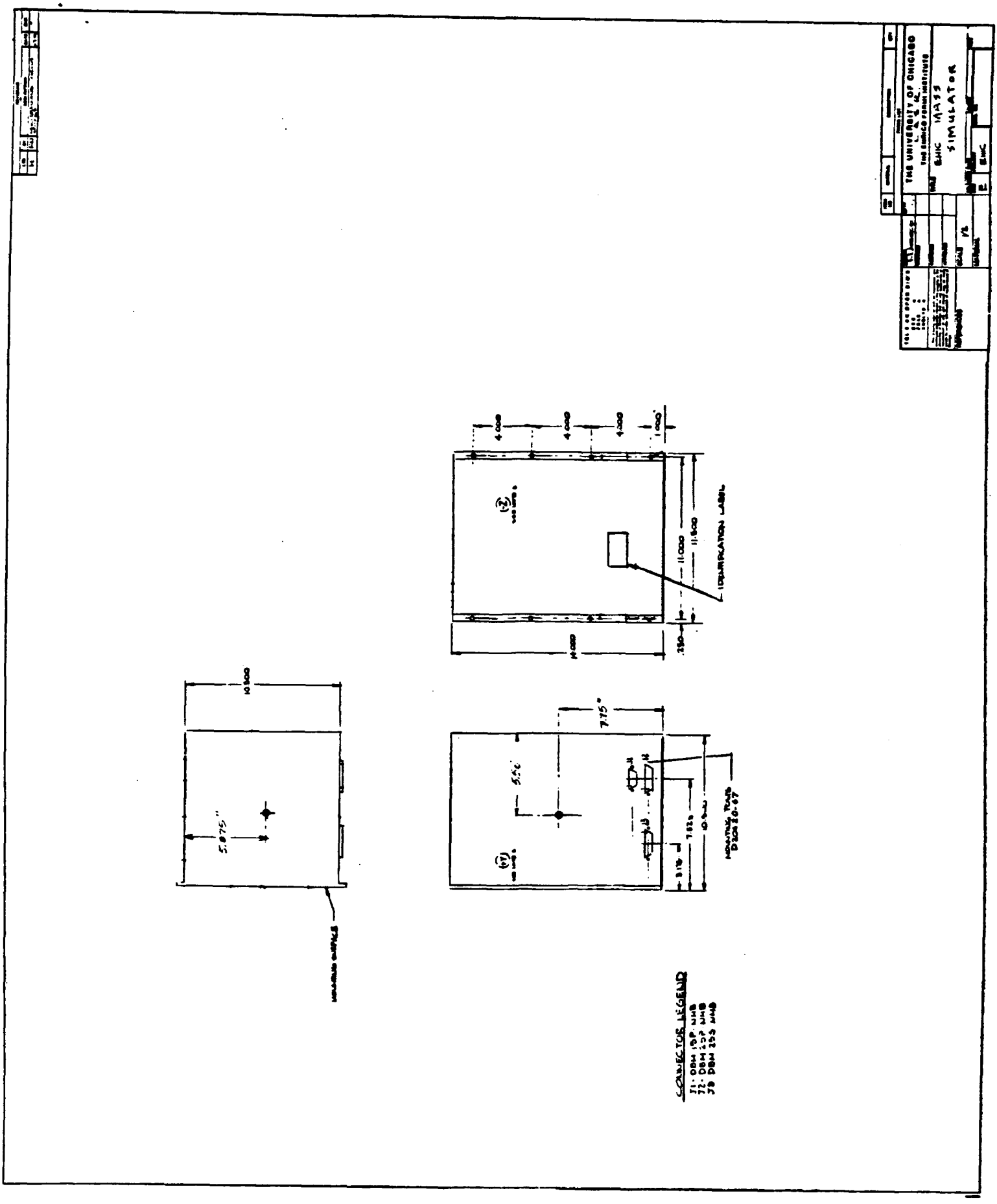


CONNECTOR LEGEND

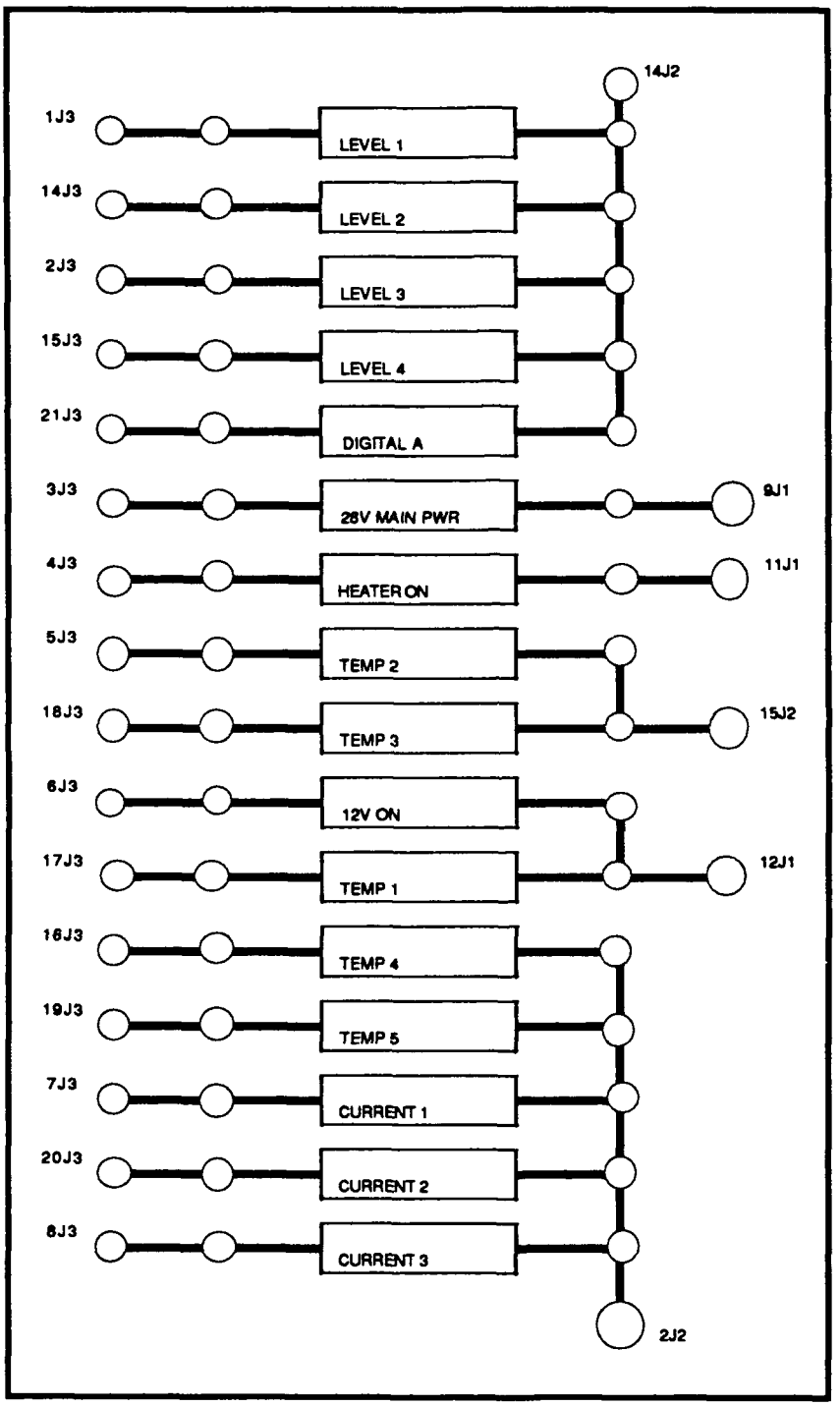
J1 DBM 15P NMB
J2 DBM 25P NMB
J3 DBM 25S NMB

1. COORDINATE IS DIRECTION SIDE IS FACING
2. UNIT REFERENCE DESIGNATION: EHIC
3. MEASURED UNIT WEIGHT: TBD (EST 30 LBS)
   TOTAL WEIGHT OF EHIC: 30 LBS. MAX.
   SHIELD WEIGHT (THERMAL BLANKET): TBD
4. UNIT VOLUME: 1820 IN^3
5. CENTER OF GRAVITY: ⌖
6. UNIT BASE AREA: NOT REQ'D.
7. MOUNTING SURFACE FLATNESS: .005 (WITH SHIMS)
8. DC POWER INPUT:
   +28 V MAIN POWER - 10 WATTS NOM.
   11 WATTS MAX.
   +28 V PULSE POWER - 15 WATTS MAX
   (HEATERS)
9. EXTERIOR FINISH: ALL SURFACES COATED WITH DOW 7 EXCEPT-
   COVER - GOLD ANODIZE
   TEL WINDOWS - ALUM. KAPTON
   CONNECTORS - J1, 2, 3 - GOLD PLATED
10. THERMAL MOUNTING REQUIREMENTS: UNIT SHALL BE MOUNTED ON MOUNTING BRACKET, RCA 3246172) AND THERMALLY ISOLATED FROM MOUNTING BRACKET AND SPACECRAFT
11. TELESCOPES FIELD OF VIEW: AS SHOWN
12. TEMPERATURE LIMITS:
    - ON OFF T OPERATING IN SPEC. -10°C to +10°C
      OPERATING OUT OF SPEC - 20C TO +55°C
    NON OPERATING (SURVIVAL): -40°C TO +40°C
    ALLOWABLE MIN/MAX TURN-ON: -20°C TO +35°C
    - IN STORAGE (LONG TERM) +5°C TO +25°C
13. X, Y, AND Z AXES REFER TO SPACECRAFT AXIS
14. UNIT IS THERMALLY PROTECTED WITH THERMAL BLANKET SHIELDING ALL SURFACES EXCEPT FELLOW ANGLE FELLOW ANGLE IS THERMALLY VAPED AFTER BAKE: TBD

THE UNIVERSITY OF CHICAGO	
L A & R	
THE ENRICO FERMI INSTITUTE	
TITLE	EHIC SPACE ENVELOPE AND CONTROL INTERFACE DRAWING
SCALE	1/2
SIZE	E
CODE IDENT	EHIC
DWG NO	MD 415
REV	H

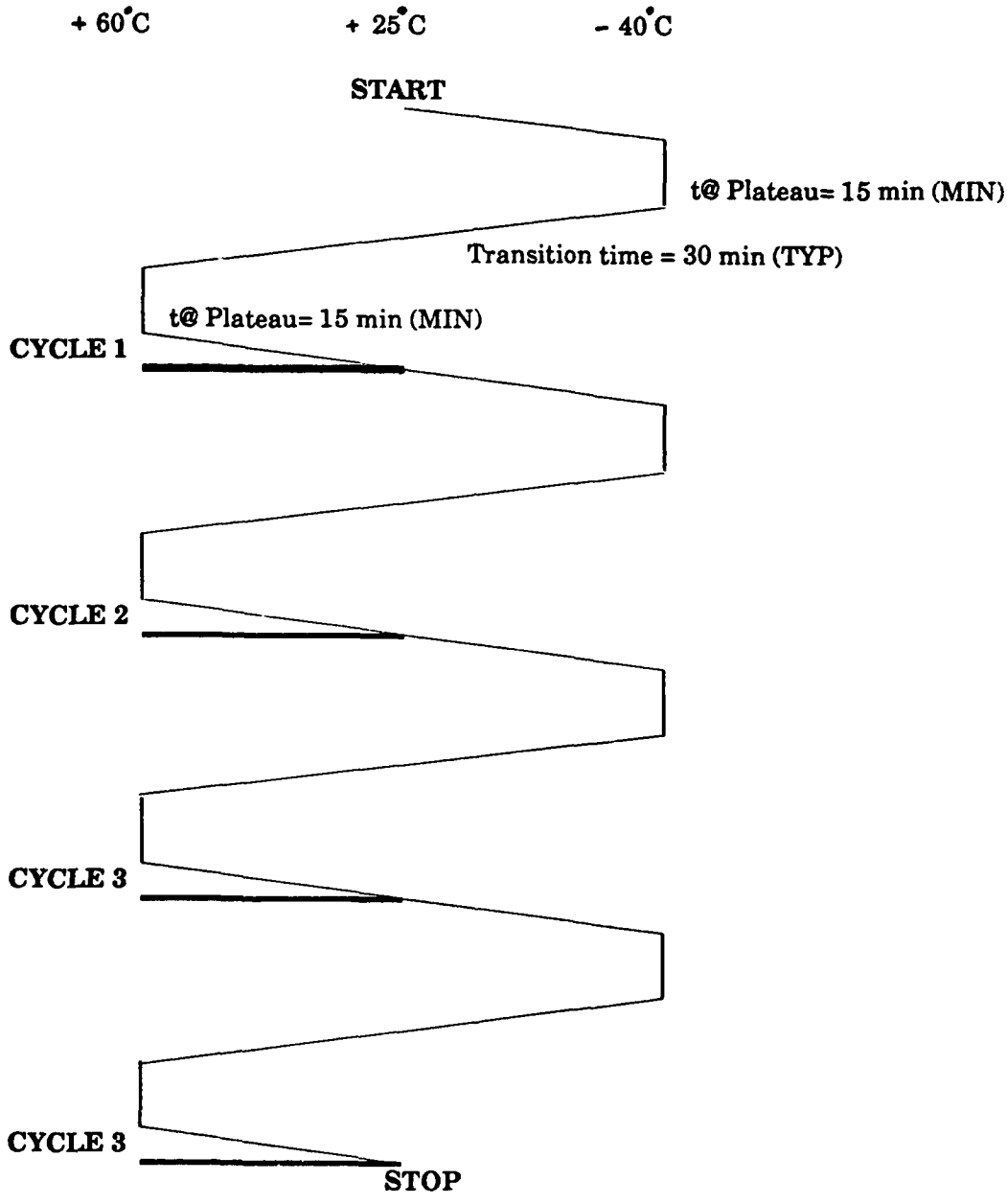

THE UNIVERSITY OF CHICAGO
EHIC MASS SIMULATOR
4.000
4.000
4.000
1.000
11.000
11.500
IDENTIFICATION LABEL
.250
4.000
10.500
5.875"
7.75"
5.5"
CONNECTOR LEGEND

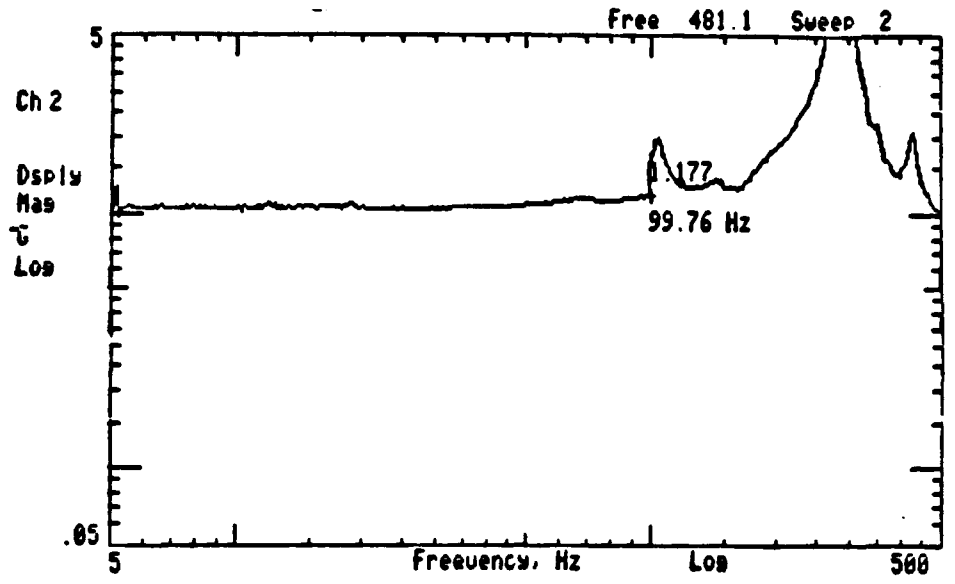
EHIC MASS SIMULATOR BUS TERMINATION BOARD



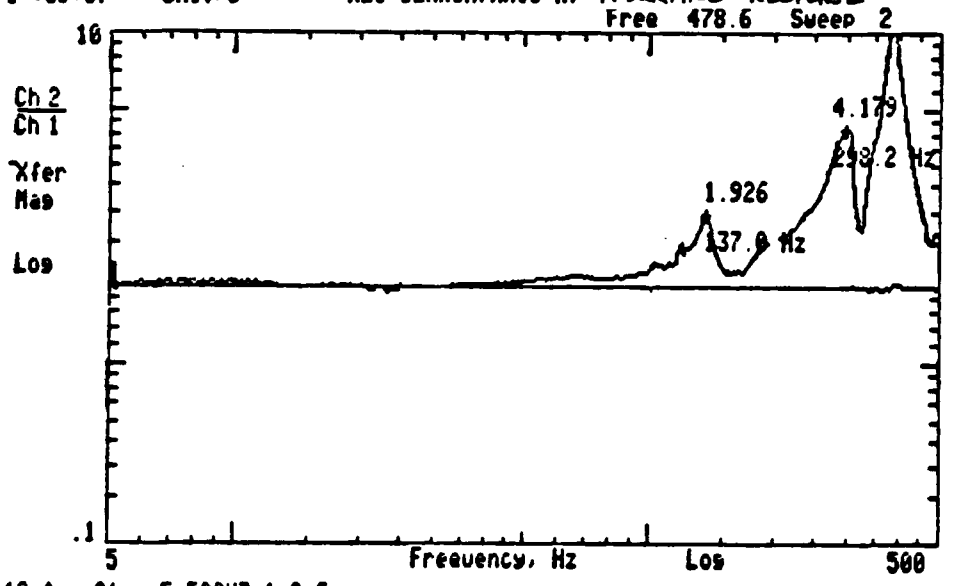
Board size: 2.6' x 1.5'

TEMPERATURE CYCLE PROFILE - MASS SIMULATOR ELECTRONICS

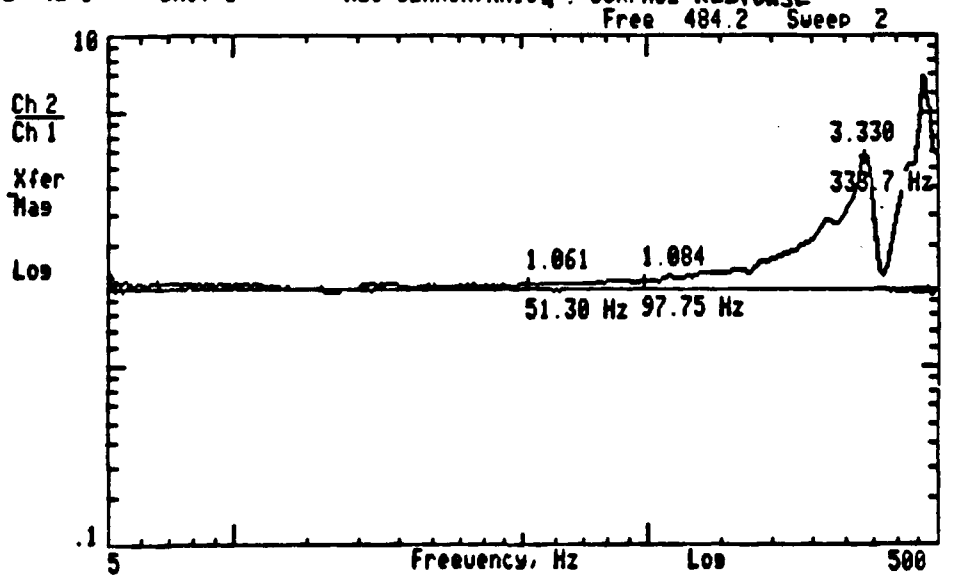




12-Apr-91 5-500HZ,1.0 G
1 :39:37 UNIV/C RES SEARCH,AXIS X,-X SURFACE RESPONSE



12-Apr-91 5-500HZ,1.0 G
2 :42:5 UNIV/C RES SEARCH,AXISY,-Y SURFACE RESPONSE



12-Apr-91 5-500HZ,1.0 G
3 :26:43 UNIV/C RES SEARCH,AXISZ,-Z SURFACE RESPONSE